MECHANISMS OF RESPONSE SUPPRESSION UNDER NONCONTINGENT REINFORCEMENT

By

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Noncontingent reinforcement (NCR) is an effective treatment for reducing behavior problems. The mechanisms responsible for NCR's effectiveness have been attributed to satiation, extinction, or a combination of both. The purpose of Study 2 was to examine the relative influence of satiation and extinction under dense NCR schedules and to determine whether the mechanism responsible for response suppression changes as the NCR schedule is thinned. Three adults diagnosed with mental retardation, displaying problem behavior maintained by social positive reinforcement (demonstrated via a functional analysis in Study 1), participated. NCR with and without extinction were compared with respect to their suppressive effects on problem behavior while the NCR

schedule was thinned. Results demonstrated that both NCR treatments initially suppressed responding of two of the participants. However, as the reinforcement schedule was thinned, NCR without extinction lost its suppressive effects and responding increased to near baseline levels for both participants. Results for the third participant indicated that only NCR with extinction was effective in reducing her problem behavior. Thus, the behavioral reductions observed appeared to be due to satiation under dense NCR schedules, whereas extinction became the operative mechanism as the NCR schedule was thinned.

Applications of NCR usually involve initially dense schedules of reinforcer delivery. Thus, it is unclear whether thin NCR schedules can suppress problem behavior. The purpose of Study 3 was to compare the effects of dense and thin NCR schedules on the problem behavior exhibited by three individuals. Results indicated that both schedules reduced problem behavior. In addition, if the goal of intervention is maintenance of low rates of problem behavior when reinforcement is delivered infrequently, the results suggested that this outcome may be achieved somewhat more quickly by using initial thin NCR schedules rather than by thinning initially dense schedules.

INTRODUCTION

The purpose of the current investigation was to evaluate the effects of noncontingent reinforcement (NCR) under different reinforcement schedules, on behavior problems exhibited by individuals with developmental disabilities. After identifying the reinforcement contingencies maintaining problem behavior (Study 1), the effects of NCR with and without extinction were compared for participants whose behavior was maintained by social-positive reinforcement (Study 2). In a third study, two different schedules of NCR (dense-to-thin and thin) were compared with respect to their suppressive effects on problem behavior maintained by social-positive reinforcement.

Functional Analysis of Behavior Problems

Research conducted over the past 20 years has shown that functional analysis methodology is a powerful assessment tool for identifying variables that maintain problem behavior. The term "functional analysis" as it is used generally in the field of operant conditioning denotes an empirical demonstration of a "cause and effect relationship" between environmental events and behavior (Skinner, 1953). Functional analyses of specific problem behaviors are based on the assumption that behavior disorders are learned performances acquired as a result of an individual's experience with the environment (Iwata, Kahng, Wallace, & Lindberg, in press). To the extent that this assumption is correct, two major sources of reinforcement account for behavior acquisition and maintenance: positive reinforcement and negative reinforcement. These

categories can be further subdivided based on the source of reinforcement for the behavior: social and automatic reinforcement.

Positive Reinforcement

Social reinforcement. The occurrence of problem behavior often sets the occasion for immediate reaction by those nearby (e.g., parents, teachers, and caregivers) in the form of reprimands, comfort, response interruption, delivery of preferred items, or attempts to engage the individual in an alternative activity. Each of these reactions, if provided contingent on the problem behavior, may function as positive reinforcement and maintain the behavior over time. For example, it has been shown that various topographies of problem behavior (e.g., self-injury, aggression, and disruption) can be maintained when followed by comforting statements made by caregivers (Lovaas & Simmons, 1969; Mace, Page, Ivancic, & O'Brien, 1986).

Automatic reinforcement. Problem behavior has also been known to persist in the absence of social reinforcement. For example, it has been shown that air swallowing (Barrett, McGonigle, Ackles, & Brukhart, 1987), rumination (Wilder, Draper, Williams, & Higbee, 1997), and self-injurious behavior (SIB) (Cowdery, Iwata, & Pace, 1990) may continue to occur independent of social contingencies. These behaviors are said to be maintained by automatic reinforcement to the extent that they directly produce their own reinforcing consequences (Vaughan & Michael, 1982). It has been suggested that these behaviors produce some sort of sensory stimulation that maintains their occurrence (Lovaas, Newsom, & Hickman, 1987).

Negative Reinforcement

Social reinforcement. The termination of ongoing activities by parents, caregivers, and teachers is another type of reaction to problem behavior. For example, it has been shown that various topographies of problem behavior (e.g., SIB, aggression, and disruption) can be maintained when followed by termination of ongoing demands (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990).

Automatic reinforcement. Problem behavior that terminates or alleviates aversive stimulation in the form of pain or physical discomfort may persist in the absence of social reinforcement. For example, when experiencing the itching caused by an insect bite, we usually scratch our skin at the site of the bite, which results in the alleviation of the itching. This source of reinforcement has been suggested to account for observed correlations between specific medical conditions and certain forms of SIB. For example, DeLissovoy (1963) observed children's head banging to be associated with ear infections.

Reinforcement-based Interventions

Functional analyses are instrumental in the development of effective treatments for problem behavior, in that they identify sources of reinforcement (i.e., social positive, social negative or automatic reinforcement) that then can be manipulated. For example, data from a number of studies have shown that treatments based on the outcome of a functional analysis are more likely to be effective than are those chosen in an arbitrary manner (Carr & Durand, 1985; Day, Rea, Schussler, Larsen, & Johnson, 1988; Iwata et al., 1994b; Repp, Felce, & Barton, 1988). By conducting functional analyses before treatment, one can specify the antecedent conditions under which behavior occurs and can alter them so that problem behavior is less likely. In addition, functional analyses

can identify the source of reinforcement that then can be eliminated in order to produce extinction. Finally, functional analyses can identify the reinforcer maintaining problem behavior so that it can be used to establish and strengthen alternative behaviors.

Antecedent Interventions

One approach to decreasing problem behavior involves the modification of conditions that exist prior to the occurrence of problem behavior. Antecedent interventions to decrease problem behavior may include manipulations of one or more of the following: discriminative stimuli, establishing operations, and response effort for both the problem behavior and for appropriate behaviors (Miltenberger, 1997). For example, Vollmer, Marcus, and LeBlanc (1994) altered antecedent conditions by providing noncontingent access to alternative reinforcers to decrease the SIB maintained by automatic reinforcement exhibited by three individuals.

Extinction

Extinction involves first the identification and then the elimination of the reinforcement contingency that maintains problem behavior (Miltenberger, 1997). For example, Mace, Webb, Sharkey, Mattson, and Rosen (1988) eliminated the bizarre speech of an individual by using extinction. A functional analysis demonstrated that the participant's bizarre speech was maintained by both escape for work and attention. The authors then reduced bizarre speech by physically guiding the participant to complete the work task contingent on bizarre speech during work sessions and by ignoring bizarre speech during attention sessions.

Differential Reinforcement

Differential reinforcement procedures that can be used to decrease problem behavior include: Differential Reinforcement of Other Behavior (DRO), which involves the delivery of the reinforcer after intervals of time in which the problem behavior does not occur; Differential Reinforcement of Alternative Behavior (DRA), which involves the delivery of the reinforcer after the occurrence of an alternative behavior; and Differential Reinforcement of Low Rates of Responding (DRL), which involves the delivery of the reinforcer if the rate of behavior is below a specified criterion (Miltenberger, 1997). For example, Marcus and Vollmer (1995) decreased one individual's disruptive behavior that was maintained by social-negative reinforcement by either differentially reinforcing communication (asking for a break) or compliance with the tasks using breaks from work as the reinforcer.

Noncontingent Reinforcement (NCR) as Treatment for Behavior Problems

Some interventions used to reduce problem behavior seem to be a combination of two or more of the above-mentioned manipulations. NCR is a prominent treatment for behavior problems that usually involves the delivery of a reinforcer according to a schedule that is not response-contingent (i.e., antecedent intervention) while eliminating the response-reinforcer contingency (i.e., extinction).

The term "noncontingent reinforcement" has recently been the subject of debate (Iwata, 1999; Poling & Normand, 1999; Vollmer, 1999). First, the term is inaccurate because it contradicts the definition of reinforcement. That is, reinforcement by definition involves a contingent relationship. In addition, NCR does not result in an increase in responding (i.e., a reinforcement effect). Several alternative terms have been

suggested to replace NCR; these include response-independent reinforcement, free reinforcement, random reinforcement, and fixed-time (FT) reinforcement. However, these alternative terms, all of which contain the term "reinforcement," are no more appropriate than NCR. Additionally, there are several justifications for the use of the term NCR over these proposed alternatives. First, NCR unambiguously conveys the absence of a contingency between a response and the delivery of a reinforcer. In addition, it is synonymous with the term response-independent reinforcement and is more specific than free or random reinforcement. In fact, random reinforcement suggests the absence of a schedule, which is not true of NCR. NCR is also more flexible than FT reinforcement because NCR also can be delivered on variable-time (VT) schedules. Additionally, NCR has a long history of usage in both the basic and applied literature. In the basic literature, its use dates back to a study conducted by Lane (1960). In the applied literature, its use dates back to the first issue of the Journal for Applied Behavior Analysis in which two studies (Bushell, Wrobel, & Michaelis, 1968; Hart, Reynolds, Baer, Brawley, & Harris, 1968) used NCR to change behavior. Moreover, there is precedent for the use of the label "reinforcement" in reference to procedures that do not result in an increase in responding. For example, DRO is a commonly accepted term that also violates the language of reinforcement, in that reinforcement is not delivered contingent upon any particular response, nor does DRO lead to an increase in responding. Rather, during DRO reinforcement is contingent on the absence of a particular response and elapsed time and results in a decrease in the target response. Although the term "NCR" may not be technically accurate, it appears to be sufficiently "technological" (see Baer, Wolf, & Risley, 1968) in guiding both research and practice. Thus, for these

reasons, the term NCR will be used to describe past research and the current investigations.

NCR was first used as a control procedure in operant conditioning experiments, as an alternative to extinction, by controlling for the contingent delivery of a reinforcer while maintaining its presence (Lane, 1960). In one of the earliest demonstrations of the use of NCR for treatment of problem behavior, Ayllon and Michael (1959) reduced hoarding behavior (e.g., collecting paper, rubbish, and magazines and carrying these items around in their clothing next to their bodies) exhibited by four patients living in a psychiatric hospital. The NCR treatment consisted of providing unlimited access to magazines by continually replenishing the ward supply and ignoring hoarding (i.e., not providing any social attention). Results showed that hoarding decreased for all participants, and the authors attributed this finding to reinforcer satiation. However, it should be noted that the effects of NCR were confounded in this study because the function of the hoarding behavior was not identified; thus, it is possible that only ignoring the behavior may have resulted in a decrease in hoarding.

NCR as a Function-based Intervention

Several studies have taken into account the maintaining function of problem behavior before implementing NCR. With the combined use of functional analyses and NCR procedures, researchers have effectively provided the maintaining reinforcer on a noncontingent basis to reduce problem behavior.

Social-positive reinforcement. One of the first studies to use the outcomes of functional analyses in developing an NCR procedure was conducted by Vollmer, Iwata, Zarcone, Smith, and Mazaleski (1993). They compared the effectiveness of NCR and

DRO in reducing SIB exhibited by three individuals diagnosed with developmental disabilities. A functional analysis indicated that all participants engaged in SIB maintained by social-positive reinforcement in the form of attention. During baseline, attention was delivered contingent on each occurrence of SIB. After baseline, the authors compared the effects of the NCR and DRO procedures using a multielement design. During the NCR condition, the therapist delivered attention according to an FT schedule and ignored problem behavior. The initial NCR schedule was FT 10-s and was then thinned to FT 5-min. During the DRO condition, the therapist delivered attention if the participant did not engage in SIB for a specified amount of time. The initial DRO interval was 10 s and was thinned to 5 min. Results demonstrated that NCR and DRO were equally effective in suppressing SIB. Numerous replications and extensions of these findings have been conducted (e.g., Derby, Fisher, & Piazza, 1996; Hagopian, Fisher, & Legacy, 1994; Hanley, Piazza, & Fisher, 1997a; Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997b; Lalli, Casey, & Kates, 1997; Marcus & Vollmer, 1996).

Social-negative reinforcement. NCR also has been used as a treatment for behavior problems maintained by social-negative reinforcement (e.g., Kahng, Iwata, DeLeon, & Worsdell, 1997; Piazza, Contrucci, Hanley, & Fisher, 1997; Vollmer et al., 1998). When NCR is used to treat problem behavior maintained by social-negative reinforcement, breaks from tasks, rather than attention or access to preferred items, are provided on an FT schedule. One of the first studies to extend the use of NCR to behavior maintained by escape from demands was conducted by Vollmer, Marcus, and Ringdahl (1995). After conducting a functional analysis to demonstrate that two participants' SIB was maintained by social-negative reinforcement in the form of escape

from demands, the authors evaluated whether providing breaks from tasks noncontingently would result in a reduction in problem behavior. During baseline, a therapist delivered instructions to the participants. A brief break was provided contingent on each occurrence of SIB. During the NCR condition, a therapist delivered instructions and presented breaks independent of SIB. Initially, breaks during NCR were provided continuously, but the schedule gradually was thinned to FT 2.5 min for one participant and to FT 10 min for the other. Results showed that NCR was effective in reducing escape-maintained SIB for both participants. The effects of NCR also were compared to those of DRO for one participant. During the DRO condition, demands were presented in the same manner as above; however, breaks were provided contingent on the absence of SIB for a specified period of time. Results showed that NCR was as effective as the DRO procedure for this individual.

Automatic reinforcement. NCR also has been used to decrease problem behavior that persists in the absence of social contingencies (i.e., that is maintained by automatic reinforcement) (e.g., Goh et al., 1995; Kennedy & Souza, 1995; Ringdahl, Vollmer, Marcus, & Roane, 1997; Shore, Iwata, DeLeon, Kahng, & Smith, 1997; Vollmer et al., 1994). In a recent investigation, Roscoe, Iwata, and Goh (1998) compared the effects of NCR to those of protective equipment (sensory extinction) on the SIB of three individuals with developmental disabilities. A functional analysis indicated that all participants engaged in SIB maintained by automatic reinforcement. The authors then conducted (a) leisure probes to identify an item that would compete effectively with SIB, and (b) equipment probes to determine the least intrusive form of protective equipment that would effectively decrease each participant's SIB. During the treatment phase of the

study, baseline sessions were identical to the alone condition of the functional analysis. After baseline, the effects of NCR and protective equipment sessions were compared in a multielement design. During the NCR sessions, the leisure item identified in the leisure probe was provided continuously throughout the session. During the protective equipment sessions, the equipment identified in the protective equipment probe was placed on the participant at the beginning of the session and remained on the participant throughout the session. Results showed that the procedures were equally effective in decreasing SIB.

These studies demonstrated that NCR is an effective treatment for problem behavior maintained by social reinforcement, both positive and negative, as well as by automatic reinforcement. Moreover, these studies demonstrate that NCR can be equally effective in reducing problem behavior when compared to other behavioral treatments such as DRO and extinction (e.g., Roscoe et al., 1998; Vollmer et al., 1993, 1995, 1998).

Advantages and Limitations of NCR

As a therapeutic treatment for behavior problems, NCR has some potential advantages. One is that NCR suppresses behavior very rapidly (e.g., Derby et al., 1996; Fischer, Iwata, & Mazaleski, 1997; Hagopian et al., 1994; Hanley et al., 1997b; Lalli et al., 1997; Roscoe et al., 1998; Vollmer et al., 1993; Vollmer et al., 1995). Another advantage is that NCR has been reported to attenuate extinction-induced phenomena (Lerman, & Iwata, 1995; Lerman, Iwata, & Wallace, 1999; Vollmer et al., 1998). NCR also is easier to implement than other treatments because it does not require a therapist or caregiver to continuously watch the participant. For example, in a DRO procedure, the therapist or caregiver must observe each instance of the problem behavior to ensure that

the resetting schedule is implemented correctly and to insure proper reinforcer delivery (i.e., delivering reinforcement only after those intervals during which the problem behavior does not occur). During NCR, reinforcers are delivered according to a time-based schedule irrespective of behavior; thus, it is not necessary for a therapist or caregiver to continuously watch an individual.

Despite these advantages of NCR as a treatment for problem behavior, some potential limitations must be noted. Although no explicit contingencies are specified with the delivery of reinforcement in noncontingent schedules, the possibility exists that some proportion of responses may be followed by reinforcers, if the scheduled reinforcer delivery occurs immediately after the occurrence of the problem behavior, which may result in response maintenance through adventitious reinforcement (Skinner, 1948). Vollmer, Ringdahl, Roane, and Marcus (1997) attributed an observed gradual increase in responding exhibited by one individual during NCR to adventitious reinforcement because the deliveries of the scheduled reinforcers were correlated with occurrences of problem behavior.

Another potential limitation of NCR as a treatment for problem behavior may be that it does not result explicitly result in the acquisition of any appropriate alternative to the target behavior. In fact, it has been demonstrated that dense NCR schedules may interfere with the acquisition of an alternative response (e.g., Goh, Iwata, & DeLeon, 2000). This interference has been attributed to the reduction in the effectiveness of a reinforcer due to its noncontingent delivery (i.e., through satiation).

Mechanisms Responsible for Behavioral Suppression under NCR

Another topic that has received attention in recent research is the identification of the mechanism responsible for behavioral suppression under NCR. Researchers have attributed NCR's effectiveness to satiation, extinction, or a combination of both (Vollmer et al., 1993). Satiation could effect behavior, in that frequent access to reinforcers may reduce an individual's motivation to engage in problem behavior, through alteration of an establishing operation (Michael, 1982). By contrast, extinction might occur during NCR because the contingency between problem behavior and its reinforcing consequence is eliminated.

Support of the satiation hypothesis can be found in a study conducted by Lalli et al. (1997), who reduced the SIB of one participant by implementing NCR without extinction, thus ruling out extinction as a source of influence. The authors first conducted a functional analysis and demonstrated that the participant's SIB was maintained by access to preferred items. During baseline, every occurrence of SIB resulted in 30 s access to the preferred object. During the subsequent NCR condition, 30 s access to the preferred object was provided according to an FT schedule (NCR), as well as contingent on SIB. Results showed a gradual decrease in the rate of SIB to near-zero levels. The authors concluded that the response suppression observed during the NCR condition was due to satiation because extinction was not included in the treatment procedure.

Fischer, Iwata, and Mazaleski (1997) were also successful in reducing problem behavior with NCR without extinction, suggesting that behavioral reduction during NCR is due to satiation. A functional analysis indicated that two participants' SIB was maintained by social-positive reinforcement (attention and access to a tangible item).

Then, the authors conducted a preference assessment to identify food items (arbitrary reinforcers), which later were demonstrated to be irrelevant to behavioral function (i.e., contingent access to food did not produce increases in SIB). The authors evaluated the effectiveness of NCR without extinction in decreasing SIB by delivering the arbitrary reinforcer according to an FT 10 s schedule and delivering the maintaining reinforcer contingent on SIB. After this condition, arbitrary reinforcers again were delivered according to an FT schedule. However, the NCR schedule was progressively thinned, and occurrences of SIB no longer were reinforced (extinction). Results showed that the delivery of arbitrary reinforcers during NCR without extinction was effective in decreasing both participants' SIB.

Support of the extinction hypothesis can be found in a study conducted by Marcus and Vollmer (1996). The authors examined the effects of combining DRA with NCR on both problem behavior and the acquisition of an alternative response for two participants to determine if satiation effects might contraindicate the use of NCR when attempting to increase appropriate behaviors with the same reinforcer maintaining the problem behavior. The authors first conducted a functional analysis and demonstrated that the participants' problem behaviors were maintained by social-positive reinforcement in the form of access to preferred items. During baseline, the preferred items were delivered contingent upon each occurrence of SIB or aggression. After baseline, a training phase was conducted during which the participants were taught to emit an alternative response to receive reinforcement. After this training phase, an NCR procedure was combined with a DRA procedure. The NCR component of the intervention consisted of delivering the maintaining reinforcer according to an FT schedule. The DRA component of the

intervention consisted of the delivery of the same reinforcer contingent on the occurrence of an alternative response. Results showed that the combination of NCR and DRA led to continued suppression of problem behavior and an increase in the alternative response. Given that the participants' alternative responses increased when both NCR and DRA were in effect, the results suggested that the individuals were not satiated to the reinforcers because they engaged in the alternative response to gain the same reinforcer that was being provided by way of the NCR schedule. Thus, the reduction in problem behavior during the NCR and DRA condition appeared to be a result of extinction.

Another hypothesis concerning the mechanism responsible for NCR's effectiveness is that both satiation and extinction may influence behavior. That is, initially dense NCR schedules may result in satiation to the reinforcer because the rate of reinforcement is greater than that delivered during baseline, whereas extinction may become the operative mechanism once the NCR schedule is thinned because the reduction in the density of reinforcement may increase the likelihood of contacting the extinction contingency. Support for this hypothesis can be found in a study conducted by Goh et al. (2000). In this experiment, the authors examined whether NCR would interfere with the acquisition of an alternative response being shaped using a DRA procedure. One difference between this study and the Marcus and Vollmer (1996) study is that Goh et al. did not conduct a separate pretraining phase, but instead tried to train the alternative response during the NCR and DRA condition. A second difference between the two studies is the speed with which the NCR schedules were thinned: Marcus and Vollmer quickly thinned the NCR schedule, whereas Goh et al. kept the initial dense NCR schedule constant for a number of sessions before thinning. A functional analysis

demonstrated that the two participants' problem behavior was maintained by social-positive reinforcement (either attention or access to preferred items). After the functional analysis, a baseline condition was conducted during which the maintaining reinforcer was delivered contingent on each occurrence of problem behavior. After baseline, the authors implemented an NCR and DRA procedure in a multiple-baseline across-subjects design. During the NCR + DRA condition, attention or access to a preferred item was delivered according to a dense NCR schedule and contingent on each emission of the alternative response. Then, the authors thinned the NCR schedule while keeping the DRA procedure intact. When the NCR schedule was dense, problem behavior was suppressed; however, the alternative response was not acquired by either participant. When the NCR schedule was thinned, problem behavior remained suppressed and both participants started to emit the alternative response. The authors suggested that the suppressive effects on problem behavior observed under dense NCR schedules were due to satiation because the alternative response was not acquired. By contrast, because the alternative response was acquired as the NCR schedule was thinned, the authors suggested that the mechanism responsible for the observed reduction in problem behavior changed from satiation to extinction.

Kahng, Iwata, Thompson, and Hanley (in press) attempted to isolate the satiation and extinction components of NCR more clearly. Functional analyses demonstrated that all participants' problem behaviors were maintained by social-positive reinforcement. During baseline, the maintaining reinforcer was delivered contingent on each occurrence of problem behavior. After baseline, the authors implemented 10-min NCR sessions. During the NCR sessions, the maintaining reinforcer was delivered on an FT schedule

and problem behavior was ignored (dense NCR schedules were implemented initially, but thinned in later sessions). A 20-min post-NCR session was conducted after each NCR session. During the post-NCR sessions, no reinforcers were delivered and problem behavior was ignored. The authors examined the within-session patterns during and immediately after each NCR session to identify the mechanism responsible for NCR's suppressive effects. Results for one participant were consistent with a satiation interpretation (a temporary increase in responding during the post-NCR sessions). Results for another participant were consistent with an extinction interpretation (no increase in responding during the post-NCR sessions). Finally, results for the remaining two participants suggested that the mechanism changed from satiation to extinction as the NCR schedules were thinned. The second study of the present dissertation attempted to illustrate a methodology for identifying the mechanism responsible for behavioral suppression under NCR that might reveal the point at which the mechanism changes from satiation to extinction.

NCR Schedules

If indeed the mechanism responsible for behavioral suppression changes as the NCR schedule is thinned, several questions are raised with respect to NCR schedules. First, are initially dense schedules necessary for response suppression? Second, are dense schedules in fact helpful in eliminating extinction bursts?

In most applications of NCR to date, reinforcers initially were delivered under dense schedules (FT 10-s), which gradually were thinned to a more manageable schedule (i.e., FT 5-min). In an interesting exception, Hagopian et al. (1994) compared dense and thin schedules of NCR with respect to their suppressive effects on destructive behavior.

Functional analyses indicated that all four participants' destructive behaviors were maintained by social-positive reinforcement in the form of attention. During baseline, attention was delivered contingent on each occurrence of destructive behavior. After baseline, the effects of a dense NCR schedule were compared to a thin NCR schedule in a multielement design. During dense NCR, attention was delivered on an FT 10-s schedule. During thin NCR, attention was delivered on an FT 5-min schedule. Destructive behavior was ignored during both conditions. Results showed that the dense NCR schedule greatly reduced destructive behavior, whereas the thin NCR schedule resulted in only moderate reductions. The authors then recaptured baseline levels of destructive behavior before implementing a dense NCR schedule, which was gradually thinned to an FT 5-min schedule. Although the authors concluded that dense schedules of NCR may be necessary to decrease behavior, it remains unclear as to whether the thin NCR schedule would have continued to decrease problem behavior (through extinction) had the condition been continued.

Although many studies successfully have thinned an initially dense NCR schedule to more practical schedules, the thinning process may be time consuming. For example, it took Vollmer et al. (1993) an average of 35 sessions to reach an FT 5-min schedule of reinforcer delivery. Even with procedural refinements in schedule thinning, it took Kahng, Iwata, DeLeon and Wallace (in press) an average of 11 sessions to reach an FT-5 min schedule. Thus, it might be more efficient to start with a thin NCR schedule than to modify an initially dense NCR schedule. The third study of this dissertation evaluated whether thin schedules of NCR effectively can suppress behavior and evaluated whether initially implementing thin NCR schedules instead of implementing dense NCR

schedules and then thinning the NCR schedule is more efficient with respect to the time it takes to reach an end of treatment criterion.

GENERAL METHOD

Participants and Setting

The three participants were individuals who lived in a state residential facility for persons with developmental disabilities, who were referred to a specialized program for the assessment and treatment of SIB. Shelley was a 29-year-old woman diagnosed with profound mental retardation who engaged in face slapping, body hitting, and hand biting. She did not display expressive verbal skills but was able to respond to simple directions. Shelley could walk independently and had no visual or auditory impairment. Jared was a 35-year-old man diagnosed with profound mental retardation who frequently engaged in hand and arm biting that resulted in calluses on both hands. He used a few signs and gestures to communicate and could follow multiple-step directions. Jared could walk independently and had no visual or auditory impairment. Lori was a 32-year-old woman diagnosed with profound mental retardation who engaged in both SIB (banging her limbs against hard surfaces) and aggression (hitting others). She used a few gestures to communicate and followed simple directions. Lori could not walk independently and spent most of her time in a wheelchair. She had no visual or auditory impairment.

All sessions were conducted in therapy rooms of a day program located on the grounds of the residential facility. Rooms contained tables and chairs, as well as materials necessary for conducting certain conditions (see below).

Response Measurement and Reliability

The dependent variables for all studies were SIB or aggression, which were defined operationally as follows: body hitting (Shelley): forceful contact of an open hand with any part of the body; biting (Shelley and Jared): closure of the upper and lower teeth on the flesh anywhere on the hand or arm; hand banging (Lori): forceful contact of any part of a hand or wrist against a hard surface; and aggression (Lori): hitting, kicking, pinching, or scratching the therapist. Data also were collected on participants' compliance with instructions and appropriate interaction with play materials, and on therapists' delivery of attention, instructions, materials, or food.

Observers (trained graduate and undergraduate students) collected data using hand-held computers (Assistant, model A102). Data for all participants' SIB or aggression were summarized as responses per min (rpm).

A second observer simultaneously but independently recorded data during 37% of sessions in Study 1, 38% of sessions in Study 2, and 48% of sessions in Study 3. Interobserver agreement scores were calculated by dividing session time into consecutive 10-s intervals and then comparing observers' records on an interval-by-interval basis. The smaller number of responses in each interval was divided by the larger number of responses. These fractions then were summed across all intervals, divided by the total number of intervals in the session, and multiplied by 100% to get the percentage agreement between the two observers. Mean agreement scores across participants were 97.3% during Study 1 (range, 75% to 100%), 95.4% during Study 2 (range, 85% to 100%), and 96.2% during Study 3 (range, 79% to 100%).

STUDY 1: FUNCTIONAL ANALYSIS OF PROBLEM BEHAVIOR

A longstanding tradition in psychology is the classification and treatment of behavior disorders based on topographical characteristics; however, the topography of a response may reveal little about behavioral maintenance. For example, different forms of a response can be produced by the same contingency; likewise, the same response can be maintained by different contingencies. By placing greater emphasis on function rather than form, it is possible to develop effective treatment programs by identifying the reinforcement contingency to manipulate during intervention.

Because the focus of Studies 2 and 3 involved the delivery of social-positive reinforcement according to an NCR schedule as a treatment procedure, it was necessary to ensure that the participants' problem behavior was, in fact, maintained by social-positive reinforcement. Therefore, Study 1 consisted of a functional analysis, the purpose of which was to (a) verify that the participants were appropriate for inclusion in Studies 2 and 3 and (b) to identify the reinforcement that would be delivered during Studies 2 and 3.

Method

All participants were repeatedly exposed to four assessment conditions (Attention, Demand, Alone, and Play) in a multielement design, based on procedures described by Iwata et al. (1994a). In addition, Shelley and Jared were exposed to a fifth condition (Tangible) based on information obtained from interviews with their staff and through

Informal observations that suggested that their problem behavior might be maintained by access to preferred items. All sessions lasted 10 min; 3 to 5 sessions were conducted per day, usually 4 to 5 days per week.

Assessment Conditions

Attention. This condition was designed to test for behavioral sensitivity to positive reinforcement in the form of attention. The therapist and participant were present in a room containing leisure materials, to which the participant had free access throughout the session. The therapist ignored the participant throughout the session, except to deliver attention (e.g., "Don't do that, you'll hurt yourself," "Stop, you're hurting me") whenever the participant engaged in a target response.

Tangible. This condition was a variation of the attention condition and a test for sensitivity to positive reinforcement in the form of access to preferred items. Two pieces of edibles were given to each participant (popcorn to Shelley, M&M's to Jared) before the start of the session. Upon intake, these items were identified to be highly preferred via a preference assessment. When the session began, the therapist kept the edibles in view but only delivered a piece of food contingent on each occurrence of the target behavior.

Demand. This condition was designed to test for behavioral sensitivity to negative reinforcement in the form of escape from demands. The therapist initiated learning trials every 30 s using a three-prompt procedure (i.e., verbal instruction, modeling, physical guidance). Praise was delivered contingent on compliance if it occurred before physical guidance. Contingent on the occurrence of the target behavior,

the therapist terminated the trial by removing the materials and turning away until the next scheduled trial.

Alone. This condition was designed to test whether problem behavior would persist in the absence of social consequences, which would suggest that it was maintained by automatic reinforcement. The participant was observed while in a room containing no leisure materials. An observer was present in the room but did not interact with the participant.

Play. This condition was a control for the other test conditions in that presumed establishing operations and contingencies for social-positive, social-negative, and automatic reinforcement were not present. During this condition, the therapist and participant were present in a room containing leisure materials, to which the participant had free access throughout the session. The therapist delivered attention (e.g., "I like the way your playing") at least once every 30 s. No instructions were delivered, and occurrences of the target behaviors were ignored.

Results and Discussion

Figure 1 shows the results of the participants' functional analyses expressed as responses per min (rpm) of problem behavior. Shelley's and Jared's SIB (top and middle panels, respectively) occurred most often during the tangible condition (M, 16 rpm and 5.2 rpm, respectively), indicating that their SIB was maintained by contingent access to edible reinforcers. By contrast, Lori (bottom panel) engaged in SIB and aggression predominantly in the attention condition (M, 13.8 rpm), indicating that her problem behavior was maintained by contingent attention. Thus, the results of all three individuals' functional analyses indicated that their problem behaviors were maintained

by social-positive reinforcement. These results served as the basis for the NCR evaluations in Study 2 and Study 3.

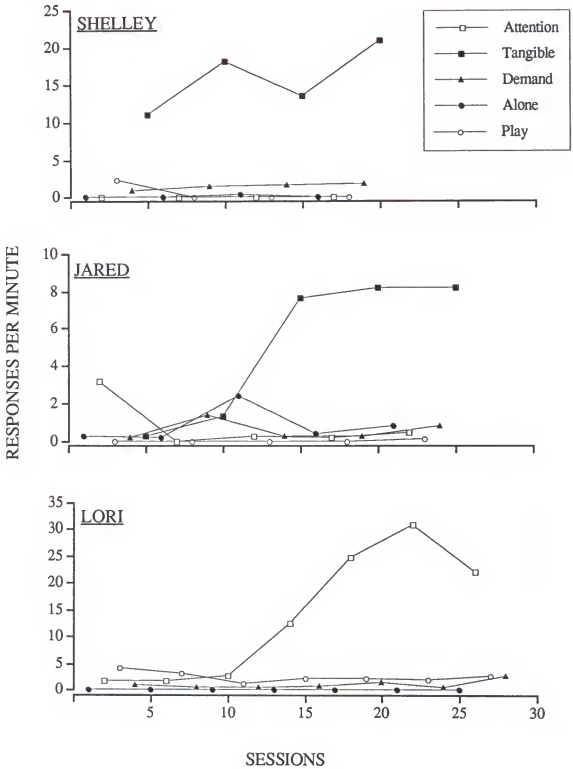

Figure 1: Responses per minute during functional analysis for Shelley (top panel), Jared (middle panel), and Lori (bottom panel)

STUDY 2: COMPARISON OF NCR WITH AND WITHOUT EXTINCTION

Previous research has demonstrated the effectiveness of NCR as a treatment for a number of problem behaviors, such as aggression, disruption, and self-injury (Hagopian et al., 1994; Vollmer et al., 1993). The mechanisms responsible for NCR's effectiveness have been attributed to satiation, extinction, or a combination of both (Vollmer et al., 1993).

NCR usually involves the delivery of reinforcers according to very dense schedules, which often produce rates of reinforcement higher than those observed during baseline (i.e., when reinforcement is delivered contingent on the occurrence of problem behavior). Thus, response suppression observed under NCR may be due to satiation in that the frequent access to reinforcers may reduce the individual's motivation to engage in problem behavior. For example, Vollmer et al. (1993) initially delivered continuous attention during treatment sessions. Lalli et al. (1997) effectively reduced problem behavior using an NCR procedure, even when problem behavior was still reinforced according to an fixed-ratio (FR) 1 schedule. Thus, because extinction was not a component of the treatment program, the suppressive effects were most likely a result of satiation.

By contrast, behavioral suppression observed under NCR may result from extinction (i.e., elimination of the contingency between the problem behavior and its reinforcing consequence). The findings of Marcus and Vollmer (1996) lend support to this hypothesis. They evaluated the effects of NCR when used in conjunction with DRA.

Results showed that, not only did problem behavior decrease, but the participants continued to engage in the alternative response, which produced the same reinforcer that was being delivered according to the NCR schedule. Thus, because they were engaging in the alternative response, it is unlikely that they were satiated to the reinforcer. Therefore, it seems likely that some other mechanism was responsible for behavioral suppression (i.e., extinction).

An explanation for these seemingly discrepant results may be provided by the findings of Goh et al. (2000) and Kahng, Iwata, Thompson, et al. (in press). These findings suggest that satiation may be the mechanism responsible for behavioral suppression under dense schedules of reinforcement but that, as the schedule of reinforcement is thinned, extinction may become the mechanism responsible for behavioral suppression. For example, Goh et al. demonstrated that NCR interfered with the acquisition of an alternative response when reinforcers were provided according to a dense NCR schedule but not when they were provided according to a thin NCR schedule. Kahng, Iwata, Thompson, et al. demonstrated that the mechanism changed from satiation to extinction as the NCR schedule was thinned by observing response patterns during a post-NCR (extinction) session. In other words, during the post-NCR sessions after dense NCR session the within-session patterns of responding showed an increase and then a subsequent decrease indicating that the individual became unsatiated to the reinforcer and contacted extinction. On the other hand, within-session patterns of responding indicated that responding remained suppressed during post-NCR sessions after NCR sessions in which the reinforcer was delivered according to a thin schedule, suggesting that responding was extinguished during the NCR session. Although these results are

promising with respect to identifying the mechanism responsible for behavioral suppression during NCR, both the Goh et al. and Kahng et al. studies indirectly evaluated the effects of extinction during NCR because both included extinction within the NCR analysis.

Thus, the purpose of this study was to directly examine the relative influence of satiation and extinction under dense NCR schedules and to determine if the mechanism responsible for behavioral suppression changes as NCR schedules are thinned. We wanted to compare NCR schedules with and without extinction to determine at what schedule extinction may become an important determinant of behavioral suppression.

Method

Shelley, Jared, and Lori participated in Study 2. All sessions lasted 10 min; 3 to 5 sessions were conducted per day, usually 4 to 5 days per week.

Experimental Sequence and Design

After baseline, the effects of NCR with and without extinction were evaluated using a multielement and a multiple-baseline across subjects design. Because NCR without extinction did not suppress Lori's problem behavior, we conducted a reversal design to demonstrate control over the NCR without extinction condition.

Experimental Conditions

Baseline. Baseline contingencies were identical to the functional analysis conditions that resulted in the highest rates of problem behavior. A small amount of edibles, popcorn or M&Ms, was provided contingent on SIB for Shelley and Jared, respectively. Brief attention (e.g., "don't hit yourself, your going to hurt yourself") was delivered contingent on SIB or aggression for Lori. A fixed-ratio (FR) 1 schedule of

reinforcer delivery for problem behavior was in effect throughout the session (i.e., every occurrence of problem behavior resulted in reinforcement).

NCR without extinction. Problem behavior resulted in the delivery of the maintaining reinforcer on an FR1 schedule. The same reinforcer was also delivered on a fixed-time (FT) schedule, with the initial schedule set lower than the lowest session interresponse time (IRT) from baseline. However, the attention given according to the NCR schedule was qualitatively different (i.e., content of statements) but was of the same duration. The NCR schedule was thinned if problem behavior was below 0.5 rpm for two consecutive sessions. Shelley's NCR schedule started at FT 2 s (30 reinforcers per min) and was thinned to FT 3 s, 4 s, 6 s, 12 s, and finally 15 s by eliminating 5 reinforcers per min until FT 12 s (5 reinforcers per min) at which point thinning was achieved by removing 1 reinforcer per min. Because 25 reinforcers per min was not divisiable into seconds, the schedule was thinned from 30 reinforcers per min to 20 reinforcer per min before following the thinning rule. Jared's NCR schedule was initially set at FT 5 s (12 reinforcers per min) and was thinned to FT 6 s, 12 s, 15 s, and finally 20 s. After initially thinning the schedule from 12 reinforcers per min to 10 reinforcers per min the same thinning rule was used to thin Jared's NCR schedule as was used for Shelley. Lori's NCR schedule was initially an FT 1-s scheduled and was not thinned because her problem behavior was not suppressed, thus never meeting the thinning criterion.

NCR with extinction. No programmed reinforcement was delivered contingent on problem behavior (i.e., problem behavior was placed on extinction). The maintaining reinforcer was delivered on an FT schedule; however, if problem behavior was contiguous with the scheduled reinforcer delivery, that reinforcer was omitted. The

initial schedule and the thinning of the schedule were identical to the NCR without extinction condition.

Results and Discussion

Results of the NCR comparison are presented in Figure 2 for all participants and are expressed as rpm. Shelley averaged 17.0 rpm of SIB during baseline (top panel). Initially, NCR (FT 2 s), whether implemented with or without extinction, suppressed Shelley's SIB. When the NCR schedule was thinned to FT 15 s, her SIB increased and maintained in the NCR without extinction condition (M, 12.5 rpm). By contrast, her SIB did not increase in the NCR with extinction condition when the FT schedule was thinned to 15 s. Jared averaged 6.2 rpm of SIB during baseline (middle panel). Upon implementation of the two NCR (FT 5 s) conditions, SIB was almost eliminated regardless of whether extinction was or was not incorporated in the treatment. As the NCR schedule was thinned to FT 12 s, SIB became variable in both conditions. The NCR schedule was then thinned to FT 15s and SIB maintained only in the NCR without extinction condition. Jared averaged 4.1 rpm of SIB at the FT 15-s schedule in the NCR without extinction condition. Extinction was then implemented in the condition originally associated without extinction for Jared, and SIB was almost eliminated (M=. 5 rpm). The NCR with extinction schedule was then thinned to a FT 20-s schedule while still suppressing SIB (M=0.15 rpm). Lori averaged 28.7 rpm of SIB and aggression during baseline (bottom panel). Implementation of the NCR with extinction treatment eliminated Lori's problem behavior. By contrast, implementation of NCR without extinction treatment did not suppress her problem behavior (M=20.2 rpm). Extinction was then included in the NCR sessions originally associated without extinction, and

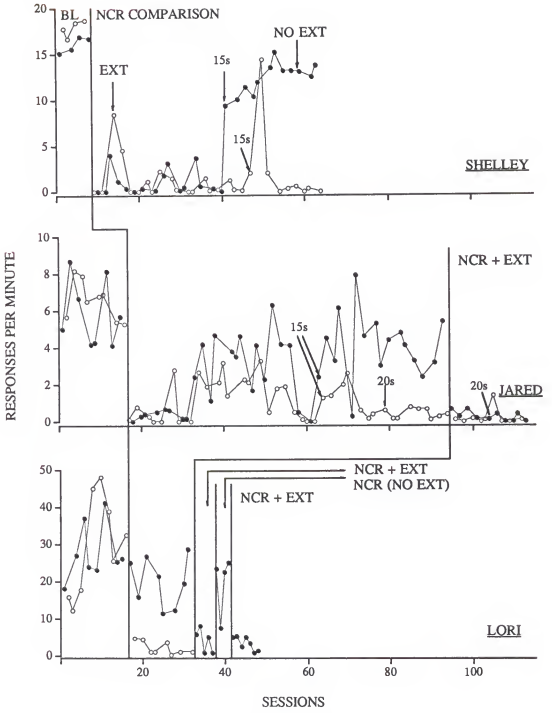

Figure 2: Responses per minute during baseline, NCR with extinction, and NCR without Extinction sessions for Shelley (top panel), Jared (middle panel), and Lori (bottom panel)

Lori's problem behavior reduced to almost zero levels. When extinction was subsequently removed, SIB and aggression increased to an average of 20.0 rpm. Finally, extinction was reinstated within the NCR sessions, and problem behavior was suppressed.

In summary, dense schedules of NCR without extinction suppressed target behavior for two of the three participants (Shelley and Jared). For these two participants, when the NCR schedules were thinned, problem behavior increased in the NCR without extinction condition, but remained suppressed during NCR when problem behavior was not reinforced. For one participant (Lori), the dense schedule of NCR was not effective unless extinction for problem behavior was included in treatment.

Because NCR under a rich schedule was effective regardless of whether problem behavior was reinforced or extinguished for two participants, it appears that rich schedules of NCR sometimes produce satiation. However, extinction was a necessary component of NCR as the schedule of reinforcer delivery was thinned for two of the participants. This was demonstrated when the NCR schedule was thinned to FT 15 s for Shelley and FT 12 s and FT 15s for Jared: Behavior remained suppressed only in the NCR with extinction condition. Because NCR remained effective at thinner schedules only when SIB was not reinforced, it appears that response suppression under thin schedules of NCR really reflect extinction. Thus, it appears that the operative mechanism of NCR changed from satiation to extinction when the FT schedule was thinned for two of the participants. Finally, NCR without extinction was ineffective for Lori even at very

rich schedules, suggesting that extinction may be a necessary component of NCR interventions from the beginning for some individuals.

Another way to interrupt these results is looking at the relative response patterns as indicating when behavior became more sensitive to one component over the other because the condition represented a concurrent choice arrangement. For example, when the NCR schedule was dense the participants were more sensitive to the FT schedule of reinforcer delivery during both the NCR with and the NCR without extinction conditions. As the schedule was thinned, the participants became more sensitive to the extinction or FR1 component that was arranged in the conditions respectively.

STUDY 3: COMPARISON OF THIN AND DENSE-TO-THIN NCR SCHEDULES

Implementation of NCR to treat problem behavior has usually been conducted using a dense reinforcer delivery schedule (e.g., FT 10 s), which is then thinned to a more practical schedule (e.g., FT 5 min) of reinforcer delivery. However, it remains unclear whether it is necessary to start with a dense schedule. In an attempt to answer this question, Hagopian et al. (1994) compared dense and thin schedules of NCR with respect to their suppressive effects on destructive behavior exhibited by four children with developmental disabilities. The dense schedule of NCR greatly reduced problem behavior, whereas the thin schedule of NCR only moderately reduced problem behavior from baseline levels. Although the thin schedule of NCR did have some suppressive effects, the authors concluded that an initial dense schedule may be necessary to eliminate problem behavior. However, the thin schedule of NCR was only implemented for a short time (e.g., 4 and 10 sessions). Thus, if extinction is the mechanism responsible for behavioral suppression during thinner schedules of NCR (as was demonstrated in Study 2), then implementing only the thin NCR sessions for a short time, which was the case in Hagopian et al., might precluded the effects of extinction to fully eliminate behavior. Sometimes response reduction may be gradual when using extinction. If so, then brief extinction may not reveal response reduction. Thus, the question remains as to whether behavior would have reduced during the thin NCR sessions in the Hagopian et al. study had the condition been continued.

Therefore, the purposes of this study were to determine whether thin schedules of NCR can be effective in suppressing problem behavior when implemented for longer periods of time and to compare thin and dense-to-thin NCR schedules with respect to their efficiency, measured as the amount of time necessary to decrease problem behavior to a clinical level (< 0.5 rpm) at a practical level of reinforcer delivery (i.e., FT 5 min).

Method

Shelley, Jared, and Lori participated. All sessions lasted 10 min; 3 to 5 sessions were conducted per day, usually 4 to 5 days per week.

Experimental Sequence and Design

After baseline, two NCR schedules were implemented in a multiple-baseline across subjects design and their effects were compared in a multielement design. A reversal design also was used with Shelley. The comparison was concluded when either schedule resulted in five sessions below 0.5 rpm at an FT 5-min schedule of reinforcer delivery.

Experimental Conditions

Baseline. Baseline contingencies were identical to the functional analysis conditions that resulted in the highest rates of problem behavior. Brief attention was delivered contingent on SIB or aggression for Lori. A small amount of edibles (coco puffs and M&Ms) was delivered contingent on SIB for Shelley and Jared, respectively. An FR 1 schedule of reinforcer delivery for problem behavior was in effect throughout the session.

Thin NCR. The therapist delivered the maintaining reinforcer on an FT 5-min schedule. Problem behavior did not result in any programmed reinforcement.

Dense-to-thin NCR. The therapist delivered the maintaining reinforcer on an FT schedule, with the initial schedule set lower than the lowest IRT from baseline for both Shelley and Jared (3 s and 6 s, respectively). Lori's initial NCR schedule was set at an FT 10-s schedule to correspond more closely with the schedule used for the participants of the Hagopian et al. (1994) study. The NCR schedule was thinned if problem behavior was below 0.5 rpm for two consecutive sessions. The NCR schedule was thinned from FT 10 s to FT 12 s, to FT 15 s for Lori, and from FT 6 s to FT 10 s, to FT 12 s, to FT 15 s, to FT 20 s for Jared. Shelley's NCR schedule was initially a FT 3-s scheduled and was not thinned because the thin schedule immediately suppressed behavior to near zero levels. No programmed reinforcement was delivered contingent on problem behavior.

Results and Discussion

Results of the NCR schedule comparison are presented in Figure 3 for all participants and are expressed as rpm. Lori averaged 12.0 rpm of problem behavior during baseline. Both the thin NCR schedule and the dense-to-thin NCR schedule resulted in immediate suppression of problem behavior; however, the thin NCR schedule met the termination criterion when the dense-to-thin schedule had only been thinned to a FT 15-s schedule of reinforcer delivery. The comparison was completed at this point because the thin NCR schedule met the criterion for termination of treatment. Shelley averaged 13.8 rpm of SIB during the first baseline. When both NCR schedules were introduce, SIB immediately was suppressed. Upon the return to baseline contingencies, Shelley averaged 13.8 rpm of SIB. Again, SIB was suppressed very quickly when the two NCR schedules were re-implemented. Subsequently, when the thin NCR condition was implemented alone (i.e., not alternating with the dense NCR schedule), maintenance of

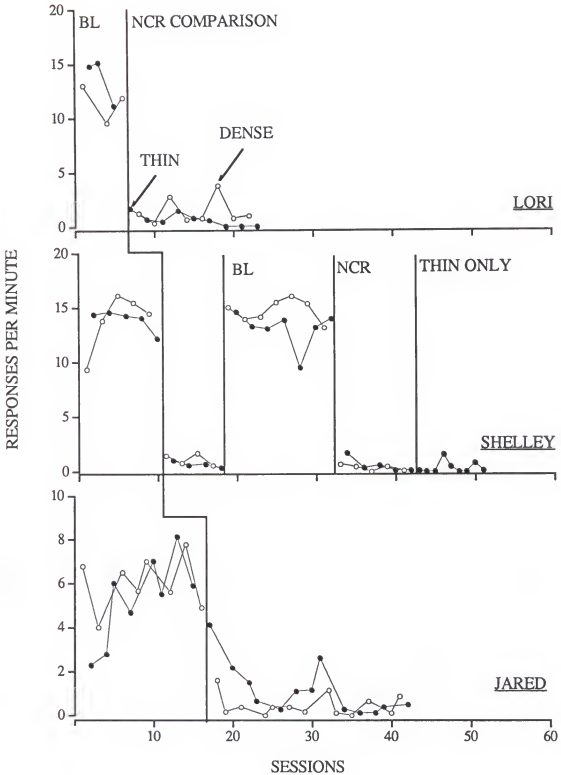

Figure 3: Responses per minute during baseline, and NCR sessions for Lori (top panel), Shelley (middle panel), and Jared (bottom panel)

behavioral suppression was demonstrated. Jared averaged 15.6 rpm of SIB. Upon implementation of the thin NCR schedule, SIB gradually decreased across five sessions. By contrast, implementation of the dense-to-thin NCR schedule resulted in a more rapid reduction in SIB. The thin NCR schedule met the termination criterion when the dense-to-thin schedule had only been thinned to an FT 20-s schedule of reinforcer delivery.

Because behavioral suppression under thin schedules of NCR seems most consistent with extinction, one possible side effect of implementing thin NCR schedules might be an extinction burst (i.e., a temporary increase in responding either in initial sessions or within the first few minutes of a session). Participants' overall session values showed no apparent extinction burst, so within-session analyses were conducted to observe whether an extinction burst occurred within the first few minutes of a session. Minute-by-minute graphical representations of responses exhibited by each individual in the last baseline and the first two thin NCR sessions (Lisa and Shelley) and the first five thin NCR sessions (Jared) are presented in Figure 4. We only included the last baseline session because it was representative of response patterns observed throughout baseline. We included all thin NCR sessions until a reduction of behavior was observed for two sessions. Lori's problem behavior gradually decreased across the first two thin NCR sessions and was absent by the seventh minute of both sessions. Shelley's SIB showed a dramatic decrease in the initial minutes of the sessions that continued across the sessions for both the first two thin NCR sessions. Jared's data are somewhat different than both Lori's and Shelley's in that he had a more gradual reduction in problem behavior across sessions with little reduction in problem behavior in the first thin NCR session. He also

showed variable within-session patterns until the third thin NCR session; however, there was no apparent extinction burst observed during any of the thin NCR sessions.

These results suggest that thin as well as dense schedules of NCR may be effective in suppressing problem behavior. Moreover, implementing thin NCR schedules from the start seemed to be somewhat more efficient (i.e., took less time to met treatment termination criterion) than implementing a dense NCR schedule and then fading to a thinner schedule with these participants. In addition, there was no noted side effect (i.e., extinction burst) associated with the implementation of the thin NCR schedule.

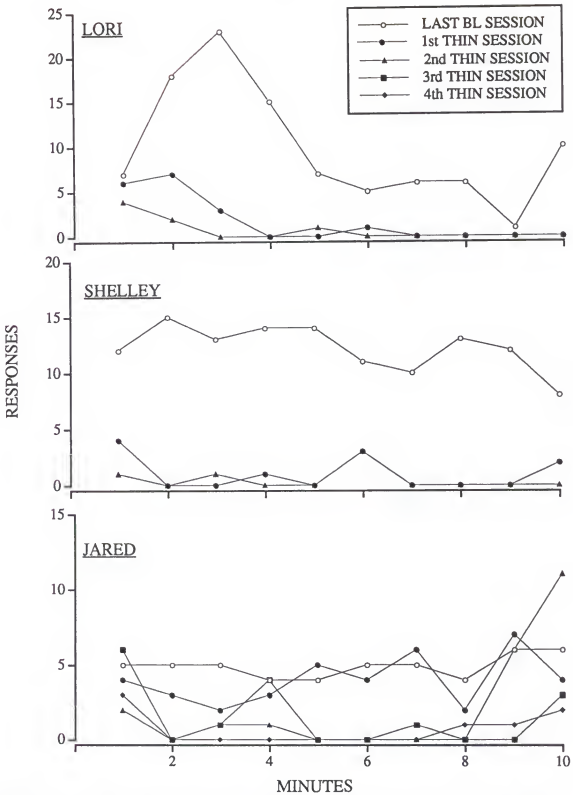

Figure 4: Number of responses across minutes during the last baseline session and the first through fourth thin NCR sessions for Lori (top panel), Shelley (middle panel), and Jared (bottom panel)

GENERAL DISCUSSION

Functional analysis methodology has been instrumental in identifying maintaining variables of problem behavior that can then be manipulated during treatment. In addition, the identification of maintaining reinforcers via functional analyses has influenced investigations of specific treatments. Moreover, functional analyses have made it possible to identify the mechanism responsible for behavioral suppression during specific interventions. The results of Study 1 identified the maintaining reinforcers for the participants' problem behavior, which allowed for the subsequent delivery of the reinforcer during NCR schedules.

Identifying the variables that maintain problem behavior is unquestionably important. Similarly, identifying the mechanisms responsible for a treatment's effectiveness is just as important, in that determining the mechanism responsible for behavioral reductions during a specified treatment has practical implications. For example, if dense NCR schedules reduce the occurrence of problem behavior through satiation (data from Study 2 support this notion), the use of extinction may be unnecessary. This may prove to be helpful information when trying to develop treatments for parents or caregivers to implement to reduce severe SIB, which sometimes cannot be ignored. On the other hand, if the goal is to reduce problem behavior that is deemed to be less severe, then implementing a thin NCR schedule will not only reduce problem behavior by way of extinction (data from Study 2 support this notion), but also

allow for some reinforcement to be provided so as not to increase the deprivation from the maintaining reinforcer. However, the question remains as to whether thin NCR schedules indeed provide enough reinforcement to reduce the possibility of extinction-induced side effects (i.e., extinction burst), although preliminary data from Study 3 provide some support that thin NCR schedules provide enough reinforcement to suppress extinction-induced side effects.

Another question with respect to the investigation of function-based treatments is how to make them more effective or more efficient. NCR is usually implemented at a dense schedule of reinforcer delivery and then thinned to a more manageable schedule. Previous research has demonstrated that dense NCR schedules are effective, thus the question remained (before the present investigation) as to whether thin NCR schedules may be effective and whether they would be as efficient as dense NCR schedules. The results of Study 3 suggest that dense NCR schedules and thin NCR schedules may be equally effective in reducing problem behavior. Thus, the choice of which NCR schedule to use may be a practical one. For example, if time is of concern (i.e., a short-term hospital stay) then implementing a thin NCR schedule seems like a logical choice (data from Study 3 indicated that thin NCR schedules were more efficient for all three participants). In addition, if the goal is to not only decrease problem behavior but also to increase an alternative response, then the use of a dense NCR schedule might be contraindicated. For example, because dense NCR schedule can produce satiation to the reinforcer, it might be more effective to implement a thin NCR schedule with a DRA procedure to reduce problem behavior while simultaneously increasing an adaptive behavior. However, whether a thin NCR schedule can be used in conjunction with a

DRA procedure to decrease problem behavior and increase adaptive behaviors remains an empirical question.

Although the results of Study 3 seem promising, conclusions based on these results must be tempered. First, the patterns of responding during the thin NCR condition differ from those obtained by Hagopian et al. (1994) in that we obtained immediate suppression in responding and they obtained a more gradual suppression. Although, behavorial suppression under extinction usually results in either a gradual suppression or an extinction burst followed by a gradual suppression, previous research has demonstrated that suppression under extinction can be immediate (e.g., Sajwaj, Twardosz, & Burke, 1972; Kuhn, DeLeon, Fisher, & Wilke, 1999). Second, our participants had all been exposed to extinction in the second study, thus the comparison of the thin NCR condition to the dense NCR condition was not completely fair, in that previous research as shown that behavioral suppression under extinction can be immediate if behavior has been extinguished in prior conditions (e.g., Carr, Newsom, & Binkoff, 1980).

One question that arises from these results is if thin NCR really represents extinction, then why not just implement extinction alone? Future research should examine whether providing reinforcement on a thin schedule has any potential positive side effects that would warrant its use over extinction as a sole intervention. For example, does providing reinforcement on such a thin schedule have any affect on altering an individuals motivation to engage in the target behavior? On the other hand, could implementing a thin NCR hinder behavioral suppression, in that providing reinforcement according to a thin schedule represents a stimulus condition that is similar

to the stimulus condition associated with contingent reinforcement, which might result maintenance of behavior (Rescorla & Skucy, 1969)?

Regardless of the NCR schedule implemented, future research should investigate the long-term effects of both NCR schedules (i.e., dense and thin). Most NCR studies have examined NCR during brief (10-15 min) sessions but have not evaluated the feasibility of implementing NCR over longer periods of time. For example, it may be the case that one schedule of reinforcement delivery (dense or thin) is more effective when implemented over an extended period of time or that one schedule is easier to implement than the other.

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BIOGRAPHICAL SKETCH

Michele D. Wallace received a Bachelor of Arts degree in psychology from Florida International University in 1994. After graduation, she found employment with Behavior Analysis Inc. in Miami, FL. She served as a behavioral consultant conducting assessments and treatments of severe behavior problems exhibited by individuals diagnosed with developmental disabilities in home, school, and workshop settings. Her growing interest in using behavioral techniques to assess and treat behavior problems led her to seek graduate training in the field of behavior analysis.

In the Fall of 1995, Michele enrolled in the experimental analysis of behavior program at the University of Florida to pursue a doctoral degree in psychology. Her studies have included both theoretical and applied behavior analysis courses. She worked as a graduate research assistant at the Florida Center on Self-Injury under the supervision of Dr. Brian Iwata. Her work has focused on the assessment and treatment of severe behavior disorders.

Expecting graduation in summer 2000, Michele will take an Assistant Professor position at the University of Nevada, Reno, where she will continue to conduct applied research and teach behavior analysis.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Brian A. Iwata, Chairman
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Carol Van Hartesveldt
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy R. Vollmer
Assistant Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Cecil Mercer
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This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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